

INSTRUCTION MANUAL

BK PRECISION

3300

PULSE GENERATOR



BK PRECISION

**DYNASCAN
CORPORATION**

WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must often be performed where exposed voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Higher voltages pose an even greater threat because such voltages can more easily produce a lethal current. However, voltage as low as 35 volts DC or AC RMS should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. Don't expose high voltage needlessly. Remove housings and covers only when necessary. Turn off equipment while making test connections in high voltage circuits.
2. Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment; and make certain such surfaces are not damp or wet. Where insulated floor surface is not available, wear heavy gloves.
3. Use the time-proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.
4. Always use an isolation transformer to power transformerless "hot chassis" equipment, where one side of the AC power line is connected directly to the chassis. This includes most recent television sets and audio equipment. Without an isolation transformer, the chassis of such equipment may be floating at line voltage (120 VAC, 60 Hz in USA), depending upon which way the 2-wire AC power plug is inserted. Not only does this present a dangerous shock hazard if the chassis is touched, but damage to test instruments or the equipment under test may result from connecting the ground lead of some test instruments to a "hot" chassis. The ground lead of most oscilloscopes and most other test instruments with 3-wire power plugs is an earth ground.
5. On test instruments or any equipment with a 3-wire AC power plug, use only a 3-wire outlet. This is a safety feature to keep the housing or other exposed elements at earth ground.
6. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.
7. Also remember that AC line voltage is present on some power input circuit points such as on-off switches, fuses, power transformers, etc., even when the equipment is turned off.
8. Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardio-pulmonary resuscitation) first aid is highly recommended.

Instruction Manual
for
Model 3300
Pulse Generator

BK PRECISION **DYNASCAN**
CORPORATION

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INTRODUCTION

The Model 3300 Pulse Generator is an extremely versatile instrument, capable of generating almost any pulse signal required in a design lab, classroom, incoming inspection test facility, production test facility, service shop, field service site, or hobbyist lab. Despite its versatility, the unit is simple to operate. Convenient pushbutton switches select the mode of operation. Separate TTL, 50-ohm, and 600-ohm outputs provide faster setup and proper matching to almost any circuit. A separate trigger output is also available. This output is commonly used to trigger an oscilloscope so that the leading edge of a pulse can be viewed, but the output can be used as a simultaneous pulse output with independently variable pulse width.

Seven decade ranges with vernier adjustment permit fully adjustable pulse repetition periods from 200 nS to 1 second, pulse width of 100 nS to 1 second, and pulse delays of 100 nS to 1 second. Pulse width is fully adjustable up to 100% duty cycle. The fast rise and fall times of the output permits use in virtually all digital logic circuits.

The outputs of the Model 3300 can be used to inject pulses for troubleshooting and signal-tracing in digital logic circuits, or almost any other circuit using pulse signals. Normal or inverted polarity is selectable by pushbutton. The amplitudes of the 50-ohm and 600-ohm outputs are independently variable. The 600-ohm output also has fully variable DC offset capability. This permits distortion-free direct coupling at the proper quiescent DC reference. All outputs of the Model 3300 may be used simultaneously if the application requires it.

A square wave mode provides a very symmetrical square wave of 0.5 Hz to 2.5 MHz. The pulse delay mode has many useful applications. For example, it converts any externally triggered oscilloscope to a delayed trigger scope with variable delay. An external triggering mode allows the pulse generator to be synchronized to an external signal, such as an external clock frequency signal, with or without delay between the trigger and the pulse output of the Model 3300. A distorted pulse can be regenerated, an external pulse can be delayed, or a non-pulse waveform can be converted to a pulse over a fully adjustable range of threshold voltage. An external gating mode allows an external gating signal to produce bursts of pulses. A manual mode allows one pulse to be generated each time a pushbutton is pressed, which is very convenient for stepping a circuit one pulse at a time, slow enough to observe circuit operation.

Convenience features such as a pilot light and OVERLAP indicator simplify operation. The OVERLAP indicator lights if the pulse width is improperly set greater than the pulse period. The tilt stand adjusts the instrument to several convenient viewing angles, and also serves as a carrying handle. The light weight and small size of the unit enhance its portability.

The Model 3300 is a full-featured pulse generator, despite its moderate cost. Engineers, technicians, and students engaged in digital and pulse electronics appreciate its "all purpose" capabilities and high standards of performance.

FEATURES

VERSATILITY	48 possible combinations of modes of operation. Single instrument meets virtually every pulse signal requirement you will ever have.
PUSHBUTTON CONVENIENCE	Pushbutton switches simplify mode selection. Mechanical interlocks prevent selection of incompatible combinations of modes.
MULTIPLE OUTPUTS	Separate TTL, 50-ohm, 600-ohm, and TRIGGER outputs. All outputs may be used simultaneously if desired.
TRIGGER OUTPUT FLEXIBILITY	Separate TRIGGER jack provides sync trigger for oscilloscope, but has many other applications. Can be used as another pulse output with different pulse width than main output. Can drive up to three TTL loads.
HIGH PERFORMANCE	50-ohm output has 15 nanosecond rise and fall time. Reliable, simplified integrated circuit design.
WIDE RANGE	PERIOD, WIDTH, and DELAY independently variable. Each has seven decade range switch with vernier for fully variable setting. PERIOD fully variable from 200 nS to 1 second. WIDTH and DELAY fully variable from 100 nS to 1 second.
FIXED AMPLITUDE CONVENIENCE	Fixed-amplitude, TTL-compatible pulse output at TTL and TRIGGER jacks saves set-up time. TTL output drives up to 10 TTL loads.
VARIABLE AMPLITUDE FLEXIBILITY	50-ohm and 600-ohm output amplitude fully variable to meet almost any requirement. 50-ohm output variable to 10 volts peak-to-peak (open circuit). 600-ohm output variable to ± 15 volts peak-to-peak (open circuit).
DC OFFSET	DC reference of 600-ohm output fully variable from -15 to +15 volts (open circuit).
SQUARE WAVE	Pushbutton selection gives fast set-up of symmetrical square wave output. Variable from 0.5 Hz to 2.5 MHz.
FIXED DELAY	Pushbutton selects fixed 1 microsecond delay from oscilloscope trigger to start of output pulse. Fast set-up for viewing leading edge of waveform at faster sweep speeds.
VARIABLE PULSE DELAY	Fully variable delay from oscilloscope trigger to start of output pulse for maximum flexibility.

EXTERNAL TRIGGER OPERATION

Output pulse can be triggered from (or synchronized to) an external signal. Can regenerate pulse at different amplitude and/or DC reference level, very useful to interface between logic families. Can invert polarity of external pulse. Can change pulse width or delay start of pulse. Any combination of above variable over wide limits.

ANALOG-TO-PULSE CONVERSION

Converts sine wave, periodic waveforms, or non-periodic waveforms to pulses. Triggering threshold variable. Can be used as level detector to provide pulse when preset voltage level is reached.

MANUAL TRIGGER

In manual mode, pulse is initiated each time button is pressed. Gives "slow motion" effect to permit observation and analysis at each step of sequence.

INVERT

Instant polarity reversal by pushbutton switch. Trigger and DC offset not inverted.

EXTERNAL GATE

External gating signal will provide bursts of pulses. Any pulse initiated before end of gating signal will be completed.

OVERLAP INDICATOR

LED indicates incorrect control settings if WIDTH exceeds PERIOD (or WIDTH plus DELAY exceeds PERIOD, depending upon mode). Lets operator know that cause of no output is improper control settings instead of instrument failure (output does not change states in overlap condition).

MECHANICAL FEATURES

Impact-resistant plastic case. Compact, lightweight unit includes combination carrying handle/tilt stand.

SPECIFICATIONS

GENERAL

Pulse Period	200 nS to 1 S (5 MHz to 1 Hz) in 7 decade ranges. Continuously variable between ranges with 1 decade linear vernier. Fully counterclockwise setting of vernier produces the minimum pulse period for selected range.
Pulse Width	100 nS to 1 S in 7 decade ranges. Continuously variable between ranges with 1 decade linear vernier. Fully counterclockwise setting of vernier produces the minimum pulse width for selected range.
Pulse and Trigger Delay	100 nS to 1 S in 7 decade ranges. Continuously variable between ranges with 1 decade linear vernier. Fully counterclockwise setting of vernier produces the minimum delay of selected range.
Maximum Duty Cycle	Capable of 100% duty cycle.

OPERATING MODES

Trigger Delay ⁽¹⁾	Leading edge of pulse output and trigger output are coincident, trailing edges are independently variable. PERIOD control sets period of both, WIDTH control sets pulse width, and DELAY control sets trigger width. By triggering from trailing edges, delays equal to trigger or pulse width are obtained.
Fixed Delay	Leading edge of pulse output is coincident with trailing edge of trigger output. Trigger output has fixed pulse width of approximately 1 μ S; thus, leading edge of pulse output is a fixed delay of 1 μ S after leading edge of trigger output.
Pulse Delay	Leading edge of pulse output is coincident with trailing edge of trigger output. Trigger pulse width is varied by DELAY control; PERIOD control sets period of both.
Square Wave	Pulse output is 50% duty cycle regardless of WIDTH control setting. PERIOD control setting corresponds to half-cycle of square wave; $\text{Square wave frequency} = \frac{1}{2 \times \text{PERIOD}}$
Invert	Trigger pulse width is independently variable by DELAY control. Inverts pulse output polarity; DC offset and trigger output not inverted.

(1) Trigger delay mode is the standard operating mode (all buttons out) and is used when only the pulse output is desired (the trigger output is not used).

External Gate	Allows external TTL signal to gate pulse output on and off. Logic "1" gates on pulses, logic "0" inhibits pulses. Pulse started before "1" to "0" transition will be completed without change of pulse width.
Pulse Amplifier	Allows TRIGGER LEVEL control to set variable threshold level for external trigger (+18 V to -18 V @ 1 kHz). Output pulse will be developed each time external trigger crosses threshold in positive-going direction.
External Trigger	Allows external trigger to initiate output pulse. Triggered by positive TTL level pulse of less than 0.25 μ S rise time.
Manual Trigger	Allows one output pulse per push of MANUAL button.

OUTPUTS

50 Ω	Continuously variable level, 0.25 V to 10 V into open circuit, 0.15 V to 5 V into 50 Ω . Rise time and fall time, less than 15 nS.
600 Ω	Continuously variable level, ± 0.3 V to ± 15 V into open circuit, ± 0.15 V to ± 7.5 V into 600 Ω . Rise and fall time less than 75 nS.
TTL	Fixed level. Logic "0" less than 0.4 V, logic "1" greater than 2.4 V. Rise and fall time less than 25 nS. Drives up to 10 TTL loads.
Trigger Out	Fixed level. Logic "0" less than 0.4 V, logic "1" greater than 2.4 V. Drives up to 3 TTL loads.

INPUTS

External Trigger	Input impedance, 10 K Ω shunted by 47 pF. Maximum voltage, 150 VDC, 120 VAC/60 Hz.
External Gate	Input impedance, 1 K Ω . Logic "0" less than 0.8 V, logic "1" greater than 2 V. Maximum input voltage 5 V.

CONVENIENCE FEATURES

DC Offset	DC reference at 600 Ω output variable from +15 V to -15 V into open circuit, +7.5 V to -7.5 V into 600 Ω .
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Overlap Indicator	LED lights when pulse width exceeds the period, or in pulse delay mode, when delay + pulse width exceeds the period.
Power Indicator	LED pilot light indicates DC power on.

MISCELLANEOUS

Front Panel Jacks	50 Ω , 600 Ω and TTL outputs, external TRIGGER INput, TRIGGER OUTput.
Rear Panel Jack	EXTERNAL GATE input.
Power Requirements	105-130 VAC, 60 Hz, 28 watts.
Size (HWD)	8.1 x 29 x 20cm (3.2 x 11.3 x 7.7").
CSA Listed	Yes.

OPERATOR'S CONTROLS

(Refer to Fig. 1 and 2)

All pushbutton switches except the MAN button are alternate action type. That is, push the button once to latch it "in", push it again to release it to the "out" position. The MAN pushbutton is a momentary action type which is spring-loaded to return to the "out" position when released.

Pushbutton switches 13 thru 15 (FIXED DELAY, TRIG OR PULSE DLY, and SQ WAVE) are mechanically interlocked so that only one of the three can be "in" at a given time. Pressing one of these buttons releases the previous selection. However, all three buttons can be "out" (press lightly on another interlocking button to release); this selects the "trigger delay" mode of operation.

Pushbutton switches 17 thru 19 (EXT GATE, PULSE AMP, and EXT & MAN TRIG) are similarly mechanically interlocked so that only one of the three can be "in" at a given time. All three of these buttons must be "out" when none of these modes is desired.

1. **TRIGGER LEVEL Control.** Sets threshold level at which generator will trigger from external signal. Active only when PULSE AMP button is engaged.
2. **TRIGGER IN Jack.** Input jack for external trigger signal.
3. **TRIGGER OUT Jack.** Output jack for trigger signal. Width of trigger is set by DELAY controls.
4. **PERIOD Range Switch (outer control).** Selects pulse repetition period (frequency) in decade steps of 0.1 μ S to 100 mS.
5. **PERIOD Vernier Control (inner control).** Continuous adjustment of repetition period between range steps. Fully counterclockwise setting provides minimum period, which is the period labeled for each range.
6. **POWER Indicator.** Lights when power is on.
7. **DELAY Range Switch (outer control).** Selects amount of delay between start of trigger output and start of pulse output (in pulse delay mode), or width of trigger output (in trigger delay mode), in decade steps of 0.1 μ S to 100 mS.
8. **DELAY Vernier Control (inner control).** Continuous adjustment of delay period between range steps. Fully counterclockwise setting provides minimum delay, which is the delay labeled for each range.

9. **OVERLAP Indicator.** Lights to indicate incorrect control setting, when width or width + delay exceeds period.
10. **WIDTH Range Switch (outer control).** Selects pulse width of output in decade steps from 0.1 μS to 100 mS.
11. **WIDTH Vernier Control (inner control).** Continuous adjustment of output pulse width between range steps. Fully counterclockwise setting provides minimum width, which is the width labeled for each range.
12. **POWER Switch.**
13. **FIXED DELAY Switch.** Delays start of pulse output approximately 1 μS after start of trigger output.
14. **TRIG OR PULSE DLY (Trigger or Pulse Delay) Switch.** With button out (trigger delay mode), start of trigger and pulse outputs are coincident and their duration is independently adjustable. WIDTH controls adjust duration of pulse output and DELAY controls adjust duration of trigger output. With button in (pulse delay mode), start of pulse output is delayed to trailing edge of trigger output. DELAY controls adjust duration of trigger *and* pulse output delay.
15. **SQ WAVE (Square Wave) Switch.** Selects symmetrical square wave output. Period of one cycle of square wave is twice the PERIOD controls setting (1/2 frequency).
16. **INVERT Switch.** Press to invert polarity of output pulse (trigger is not inverted).
17. **EXT GATE (External Gate) Switch.** Generator will produce burst of pulses when gate signal is applied from external source to EXT. GATE jack on rear of unit.
18. **PULSE AMP (Pulse Amplifier) Switch.** Generator will produce one pulse whenever external signal applied at TRIGGER IN jack crosses threshold level set by TRIGGER LEVEL control.
19. **EXT & MAN TRIG (External and Manual Trigger) Switch.** Generator will produce one output pulse when signal applied at TRIGGER IN jack crosses a fixed TTL level, or the MAN button is pushed.
20. **MAN (Manual) Switch.** One trigger and one output pulse generated per push. Active only when EXT & MAN TRIG button is engaged.

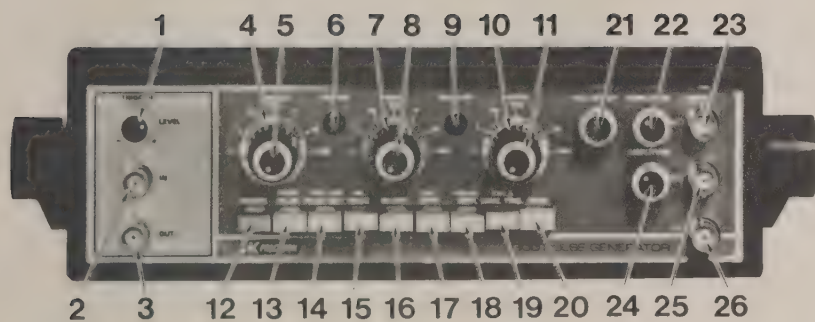


Fig. 1. Operator's controls, front panel.

21. **DC OFFSET Control.** Adjusts DC reference voltage at 600 Ω OUTPUT jack. Fully counterclockwise rotation produces maximum negative DC, fully clockwise produces maximum positive DC, center is zero.
22. **600 Ω AMPLITUDE Control.** Adjusts amplitude of 600 Ω OUTPUT pulse.
23. **600 Ω OUTPUT Jack.**
24. **50 Ω AMPLITUDE Control.** Adjusts amplitude of 50 Ω OUTPUT pulse.
25. **50 Ω OUTPUT Jack.**
26. **TTL OUTPUT Jack.** Fixed level, TTL compatible pulse output.
27. **Carrying Handle/Tilt Stand.**
28. **EXT. GATE (External Gate) Jack.** Input jack for external burst gate. Located on rear panel, see Fig. 2.
29. **Line Cord Receptacle.** Located on rear panel, Fig. 2.

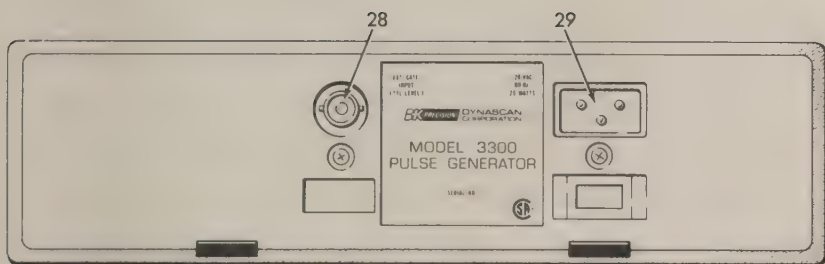


Fig. 2. Rear panel facilities.

OPTIONAL ACCESSORIES (Not Shown)

The following cables are available separately if desired for versatility in connecting the Model 3300 Pulse Generator to a variety of other equipment:

Model	Description
CC-41	36" RG/58U coax, BNC to BNC.
CC-42	36" RG/58U coax, BNC to UHF (PL-259).
CC-43	36" RG/58U coax, BNC to dual banana plug.
CC-44	36" RG/58U coax, BNC to microphone connector.
CC-45	36" RG/58U coax, BNC to type N.

The following adapters are available from most electronics parts distributors to adapt your present cables for interconnection between the Model 3300 Pulse Generator and other equipment.

BNC receptacle to phono plug: Adapts BNC-terminated cable to plug into rear panel phono jack (Pomona Electronics Model 2957 or AVA Electronics Model 1051-24SP).

Phono jack to BNC plug: Adapts phono plug terminated cable to connect to BNC receptacle (Pomona Electronics Model 4054 or AVA Electronics Model 1030-34SP).

NOTE: The Model LC-50 Carrying Case is not recommended for the Model 3300 Pulse Generator.

OPERATING INSTRUCTIONS

The Model 3300 Pulse Generator is a very versatile instrument. A total of 48 modes of operation are possible, and this does not include any of the continuously variable factors like period, width, delay, amplitude and DC offset. To gain the most value from the instrument, we recommend that you read through the entire manual to gain an understanding of the vast variety of possible uses for this unit. We further recommend that you familiarize yourself with the instrument's operating characteristics and versatility by connecting the output(s) of the pulse generator to an oscilloscope and trying as many combinations as possible. A dual-trace oscilloscope is recommended, as it will allow you to examine the relationship of the trigger output to the pulse output(s). Refer to the manual as often as required.

INITIAL START-UP PROCEDURE

1. Connect AC power cord into receptacle on rear panel and plug into outlet.
2. To turn on the generator, push in the ochre (orange) POWER button. The POWER indicator will light.
3. All other pushbutton switches should be out. This is the most commonly used mode of operation (called the trigger delay mode, although the trigger output may not be used in many applications).
4. Set the PERIOD, WIDTH, and DELAY vernier controls fully counterclockwise.
5. The OVERLAP indicator should not be lighted. If it is, either decrease the WIDTH and DELAY range switch settings or increase the PERIOD range switch setting. For familiarization, a PERIOD setting of 1 ms and a WIDTH and DELAY setting of 100 μ s is a good starting point.

TRIGGER DELAY MODE

The trigger delay mode could also be called the "standard" or "normal" mode of operation, since it is probably the most commonly used. It is also the frame of reference to which other modes are compared. This is the mode that is used if only a pulse output is desired (TRIGGER OUT not used). The output can be taken from the 50 Ω , 600 Ω , or TTL OUTPUT: the next section gives some considerations for choosing the output in various situations.

This is also the mode to use if two simultaneous pulses are needed with different pulse widths. The pulse output is set with the WIDTH controls and the trigger output is set with the DELAY controls. The PERIOD controls set the period of both outputs.

Refer to Fig. 3 and the following procedure for setting up the trigger delay mode.

1. All buttons except **POWER** should be out.
2. Make sure the **OVERLAP** indicator is off. If lighted, set **PERIOD** or **WIDTH** controls to turn it off.
3. If **TRIGGER OUT** is to be used, connect it to the channel A input of a dual-trace oscilloscope.
4. Connect the desired pulse output (50Ω , 600Ω , or **TTL OUTPUT**) to the channel B input of a dual-trace oscilloscope. If the trigger output of step 3 is not to be used, the pulse output should be connected to the channel A input of the scope.
5. Adjust oscilloscope controls to display the waveform(s) produced by the pulse generator.
6. If the 50Ω **OUTPUT** is selected, set 50Ω **AMPLITUDE** control for approximate pulse amplitude required in circuit where pulse is to be applied. If 600Ω **OUTPUT** is selected, set **DC OFFSET** and 600Ω **AMPLITUDE** to approximate values required in circuit where pulse is to be applied.
7. Set **PERIOD** controls for desired pulse repetition period. Use oscilloscope to measure time duration. For more precision measurement, use the period measurement function of a frequency counter, or by using the frequency measurement function of the counter and calculating the period thus:

$$\text{Period} = \frac{1}{\text{Frequency}}$$

8. Set **WIDTH** controls for desired pulse width. Use oscilloscope to measure time duration.
9. If trigger output is used, set trigger pulse width with **DELAY** controls. Measure time duration on oscilloscope.

CAUTION

Power should be applied to logic circuits before pulses are injected. Damage to gate inputs may occur if power is not applied. Also make sure pulse amplitude and DC offset is correct to prevent damage from overvoltage.

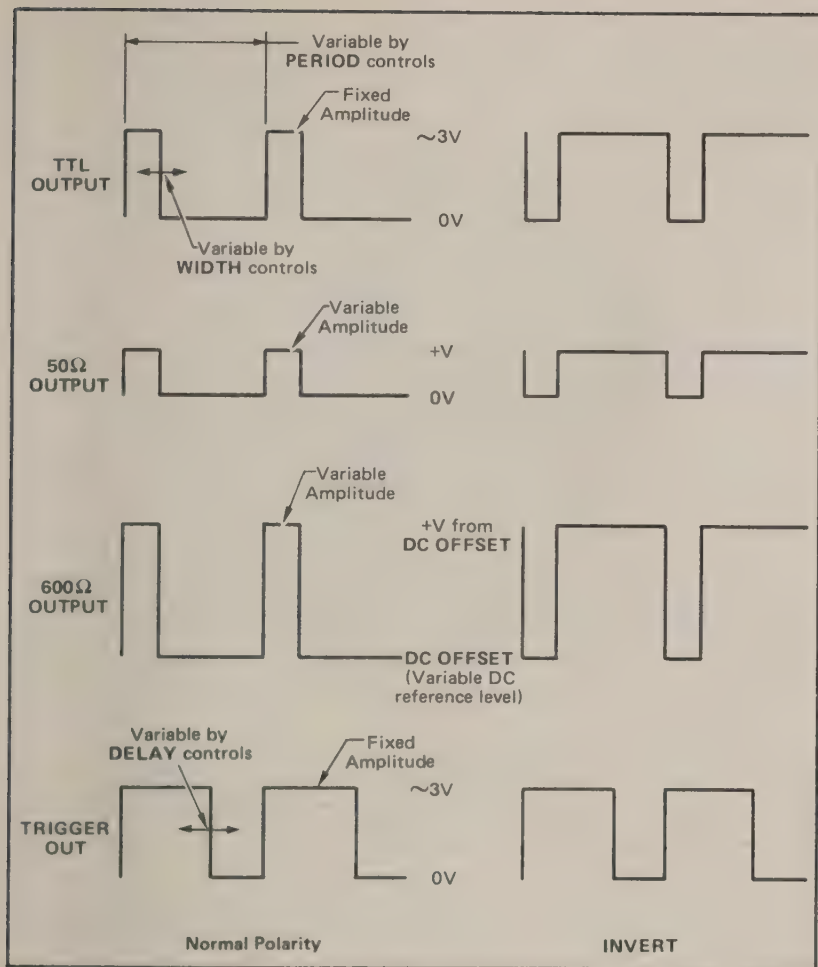


Fig. 3. Outputs in trigger delay mode.

- With signal still displayed on oscilloscope, apply pulse output (and trigger output if used) to circuit under test. If 50 Ω or 600 Ω OUTPUT is used, readjust AMPLITUDE control for desired amplitude under load.

PULSE OUTPUT CONSIDERATIONS

The three main pulse outputs each have their own distinct applications. The best results will be obtained if you understand the characteristics of each output

and select the one that best matches each application. The 600 Ω output has large voltage swings and adjustable amplitude output. The 50 Ω output has higher power and faster rise and fall times. The TTL output has the convenience of fixed TTL level signal. The 600 Ω and 50 Ω outputs have source impedances of 600 ohms and 50 ohms respectively, but they can be fed into any circuit impedance. However, the output amplitude varies in proportion to the terminating impedance. Also, ringing may occur — especially in the 50 Ω output due to its fast rise and fall times — from an impedance mismatch between the pulse generator and the signal termination. To minimize the ringing and maintain a relatively constant output level while injecting pulse signals into various circuits, it is recommended that each of these outputs be terminated in its characteristic (source) impedance. When the pulse generator output is connected to a coaxial connector on the equipment under test, it usually presents a 50-ohm terminating impedance, although coaxial cable is also used with 600-ohm circuits for its shielding properties. The most convenient way to terminate a shielded cable is to add a coaxial tee in the output cable and connect a 50-ohm or 600-ohm termination to one leg. This provides a characteristic terminating impedance when injecting a pulse signal into a high-impedance circuit. Remove the termination when injecting signal into a 50-ohm or 600-ohm circuit.

To set the output amplitude to a specific level, measure the peak-to-peak amplitude on an oscilloscope. Measure pulse amplitude with the signal injection probe connected to the circuit, because various terminating impedances affect the amplitude of the output. Do not exceed the amplitude for which the circuit is designed, as damage from overvoltage could result.

Keep in mind DC consideration. If a DC voltage is present at the point of signal injection, use the 600 Ω output and adjust the DC OFFSET to match the voltage, or use a blocking capacitor in series with the output. The fall time of the 50 Ω output may degrade if a blocking capacitor is used.

To set the output frequency (PERIOD) with precision, use a frequency counter. An oscilloscope will generally give enough precision for pulse width and delay settings.

600 Ω Output

The 600 Ω output has the capability of variable amplitude, large voltage swings, and built-in DC offset. The 600 Ω output is a positive-going pulse referenced to the DC offset voltage. The DC offset is variable from -15 to +15 volts (open circuit) or -7.5 to +7.5 volts (into 600 ohms). When the INVERT button is engaged, the output is a negative-going pulse referenced to the DC offset voltage.

The absolute limits of signal swing plus DC offset are -15 and +15 volts (open circuit) or -7.5 and +7.5 volts (into 600 ohms). Clipping will occur above these levels, as shown in Fig. 4. To achieve maximum signal swing, the DC OFFSET

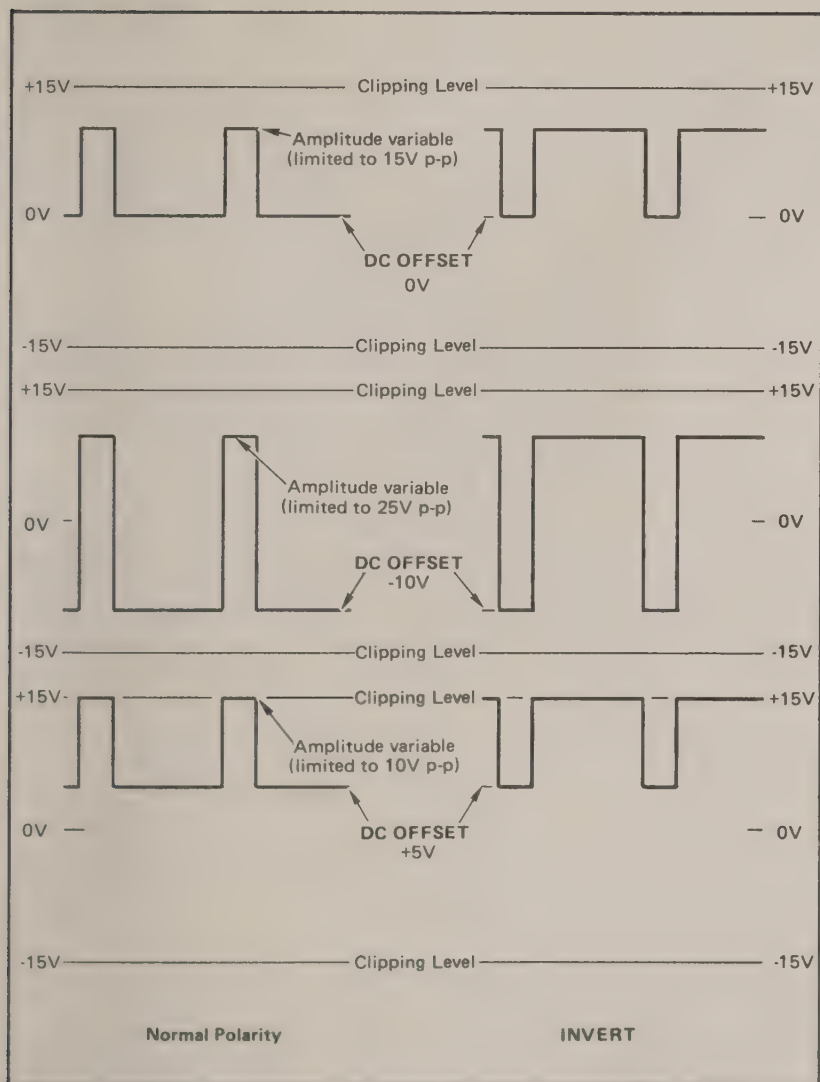


Fig. 4. Effects of DC offset.

control must be set to its maximum negative value. Clipping is not as apparent with a pulse waveform as with sine wave or triangle wave signals, as the waveshape is not altered. The output is clipping if turning the AMPLITUDE control clockwise does not increase pulse height, or turning the DC OFFSET control changes pulse height.

To set the DC offset, first measure the DC voltage at the point of signal injection without the pulse generator connected to that point. Push the EXT & MAN TRIG button, with no external trigger applied to the pulse generator. This disables the pulse output and provides the DC offset voltage only. Set the DC OFFSET control to obtain the same voltage as measured at the point of signal injection, then connect the 600 Ω OUTPUT to that point. Readjust the DC OFFSET control for the desired voltage value, because circuit loading may lower the value. Release the EXT & MAN TRIG button to obtain pulse signal output.

The DC offset voltage can be used as a bias supply as described in the previous paragraph; in that case, leave the EXT & MAN TRIG button "in".

When the Model 3300 is operating near its minimum pulse width limits, the 50 Ω output may be preferred because of its faster rise and fall times.

50 Ω Output

The faster rise and fall times of the 50 Ω output, along with the high drive capability, make it useful in high-speed circuits. The 50 Ω output is a positive-going pulse referenced to 0 volts. Refer to Fig. 3. The amplitude is variable up to 10 volts peak-to-peak (open circuit), or 5 volts peak-to-peak (into 50 ohms). When the INVERT button is engaged, the output is a negative-going pulse referenced to a positive DC voltage. The bottom portion of the pulse is at 0 volts, and the positive reference level is set by the 50 Ω AMPLITUDE control.

TTL Output

This output gives the convenience of a fixed amplitude pulse output at TTL level. The output is capable of driving up to 10 TTL loads. Fig. 3 shows that the output is a logic "1" (high) pulse referenced to logic "0" (low). When inverted, the output is a logic "0" pulse referenced to logic "1".

Trigger Output

This output is also a fixed amplitude pulse at TTL level. Its rise and fall times are somewhat slower than the TTL output. It can drive up to 3 TTL loads. This output is not affected by the INVERT or SQ WAVE buttons.

INVERT

The polarity of the pulse output at the 50 Ω , 600 Ω , and TTL OUTPUT jacks can be inverted by pressing the INVERT button. The polarity of the trigger output and the DC offset are not inverted. Fig. 3 and 4 illustrate the waveforms obtainable when the INVERT button is "in".

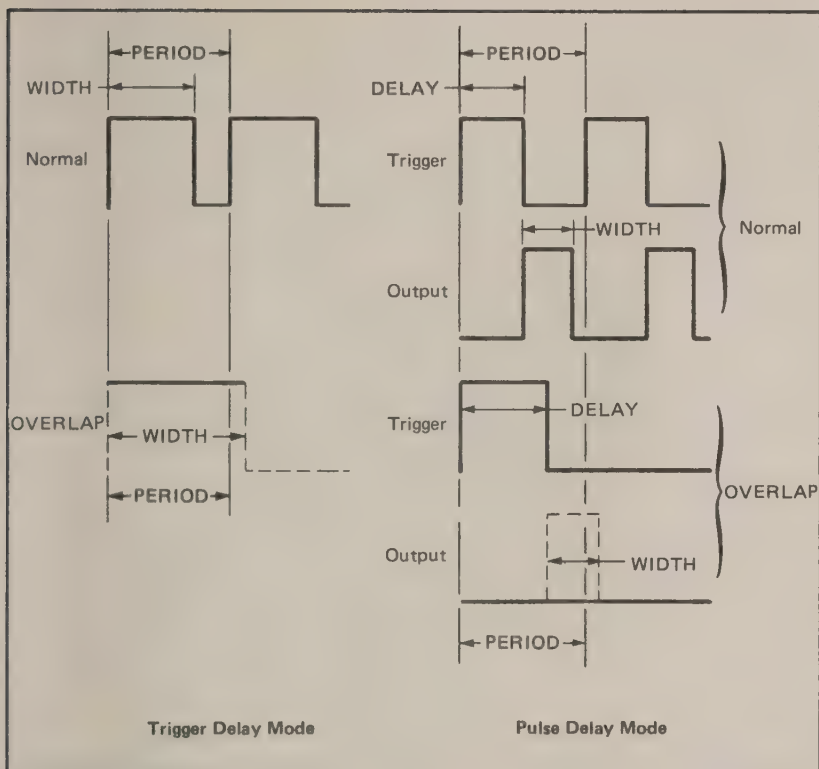


Fig. 5. Overlap conditions.

OVERLAP

In the trigger delay mode, if pulse width exceeds pulse repetition period (Fig. 5), the output will not pulse and the OVERLAP indicator will light. The light reminds the operator that controls are improperly set; otherwise, he might think the pulse generator has failed. In this mode, the DELAY can be adjusted to exceed the PERIOD without the OVERLAP indicator lighting, but the trigger output will not pulse. If the trigger output is being used for external sync of an oscilloscope, the scope will lose sync.

In the pulse delay mode, the OVERLAP indicator will light if the pulse width plus pulse delay exceeds the pulse repetition period. When the buttons EXT GATE, PULSE AMP, or EXT & MAN TRIG are used, the OVERLAP indicator may light initially until an input is applied, but will then remain off unless an overlap condition occurs.

To correct an overlap condition, turn the PERIOD control clockwise (lower frequency) or the WIDTH and/or DELAY controls counterclockwise (less width).

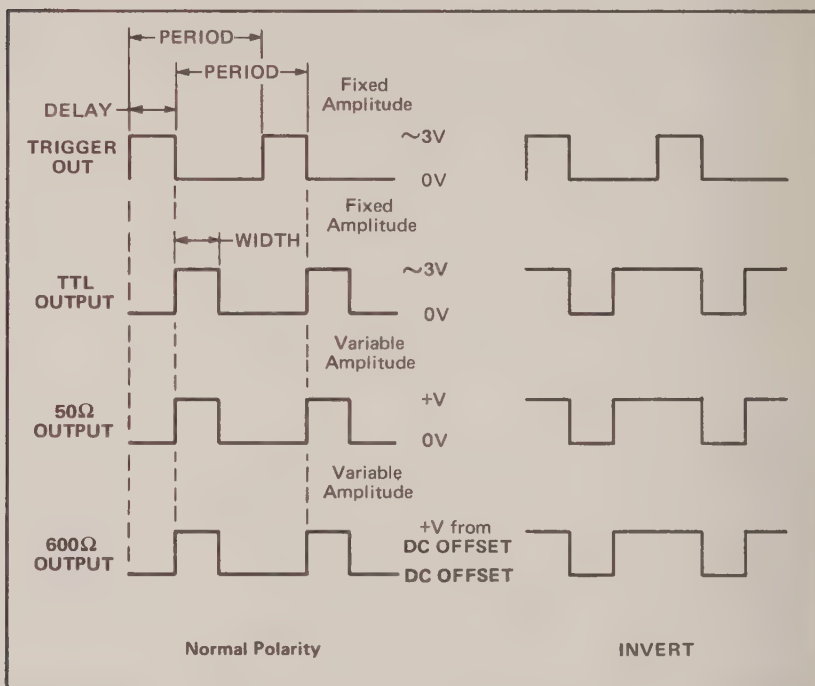


Fig. 6. Outputs in pulse delay mode.

PULSE DELAY MODE

This mode can be used to provide a delayed sweep function to an oscilloscope to permit the leading edge of the pulse to be displayed and examined. Another application can be to use the trigger output as a timing trigger for a circuit, and allow the pulse output to be delayed for application at a different point in the circuit. In this mode, the leading edge of the pulse output is coincident with the trailing edge of the trigger output. The amount of delay (width of trigger pulse) is variable by the DELAY controls as shown in Fig. 6. In this mode, the overlap circuit sums the DELAY and WIDTH settings and lights the OVERLAP indicator if the sum of both exceeds the PERIOD setting. It may be necessary to turn both DELAY and WIDTH controls counterclockwise to correct an overlap condition.

To use the pulse delay mode for delayed sweep operation of an oscilloscope, refer to Fig. 7. Connect the TRIGGER OUT jack of the Model 3300 to the external

trigger input of the oscilloscope and set up the oscilloscope for external sync operation on the leading edge of the trigger pulse. Connect the pulse output of the Model 3300 to the vertical input of the oscilloscope. Note that as the DELAY controls are varied that the pulse is shifted on the oscilloscope display. If a specific delay time is desired, use the oscilloscope and measure the time from the beginning of the sweep to the leading edge of the output pulse. On a dual-trace oscilloscope, the trigger output can be used for oscilloscope sync *and* viewed on one trace while the output pulse is viewed on the other trace.

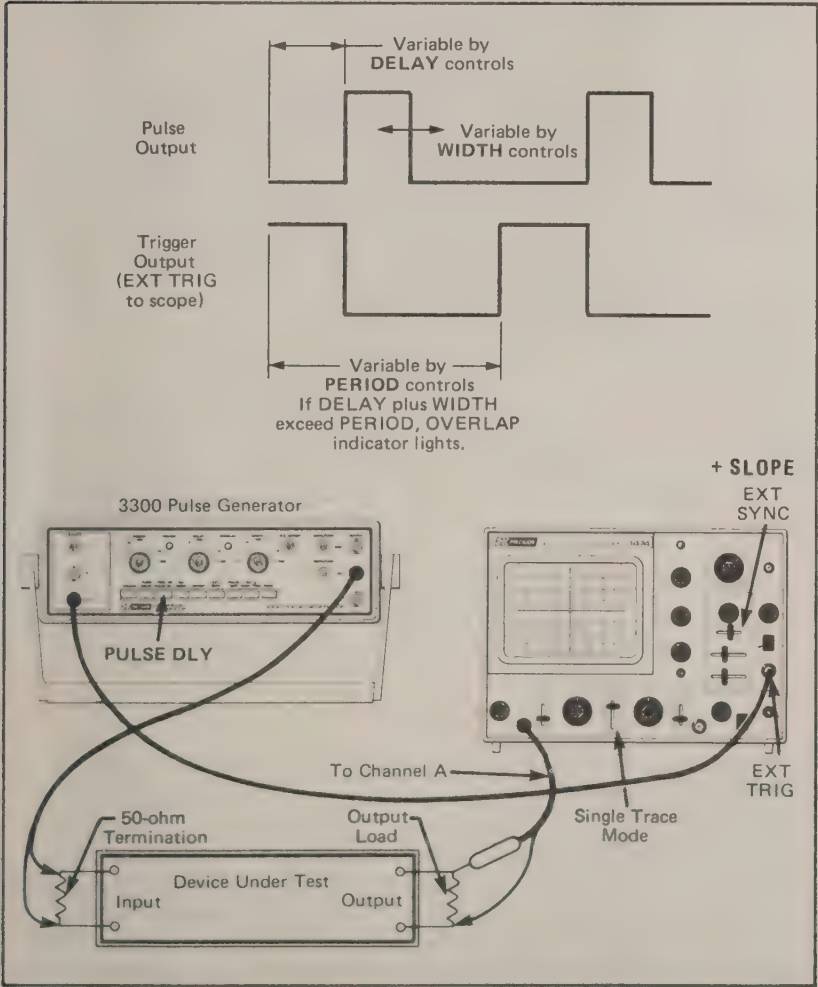


Fig. 7. Adding sweep delay using pulse delay mode.

FIXED DELAY MODE

This feature allows oscilloscopes without a built-in signal delay line to display the leading edge of a fast pulse which otherwise could not be seen. Operation is similar to the pulse delay mode, except that instead of a variable delay that is set by the **DELAY** control, a fixed delay of approximately 1 microsecond is selected. Set-up is faster because it is only necessary to press one button to initiate the mode. The **DELAY** controls are disconnected in this mode.

SQUARE WAVE MODE

The pulse output can be changed to a symmetrical square wave when the **SQ WAVE** button is "in". Fig. 8 shows that the **PERIOD** control setting is the time duration of a half-cycle of square wave signal. The **WIDTH** control has no effect in this mode. The trigger output remains unaffected.

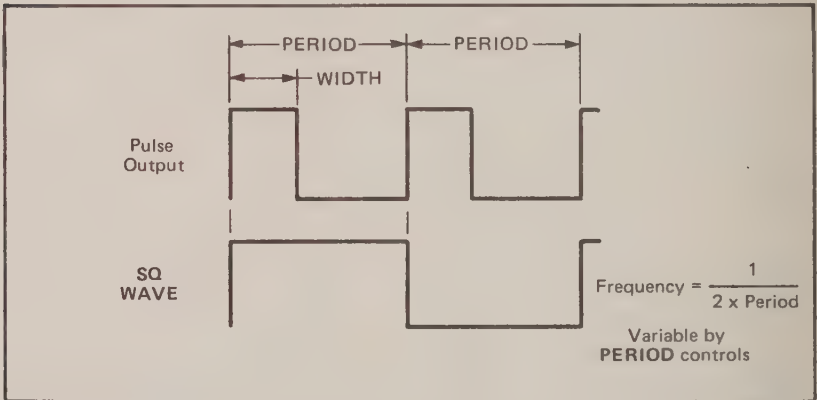


Fig. 8. Comparison of pulse and square wave output.

EXTERNAL GATE MODE

This function allows a burst of pulses to be generated under the control of a separate pulse or function generator. To demonstrate this mode a **B & K-PRECISION** Model 3010 or 3020 Function Generator or equivalent can be used. Connect a cable from the TTL output of a function generator to the **EXT GATE** jack on the rear of the Model 3300 Pulse Generator and press the **EXT GATE** button. Set up equipment as in Fig. 9. For familiarization, set the function generator for 100 Hz output and the pulse generator **PERIOD** to 1 mS and **WIDTH**

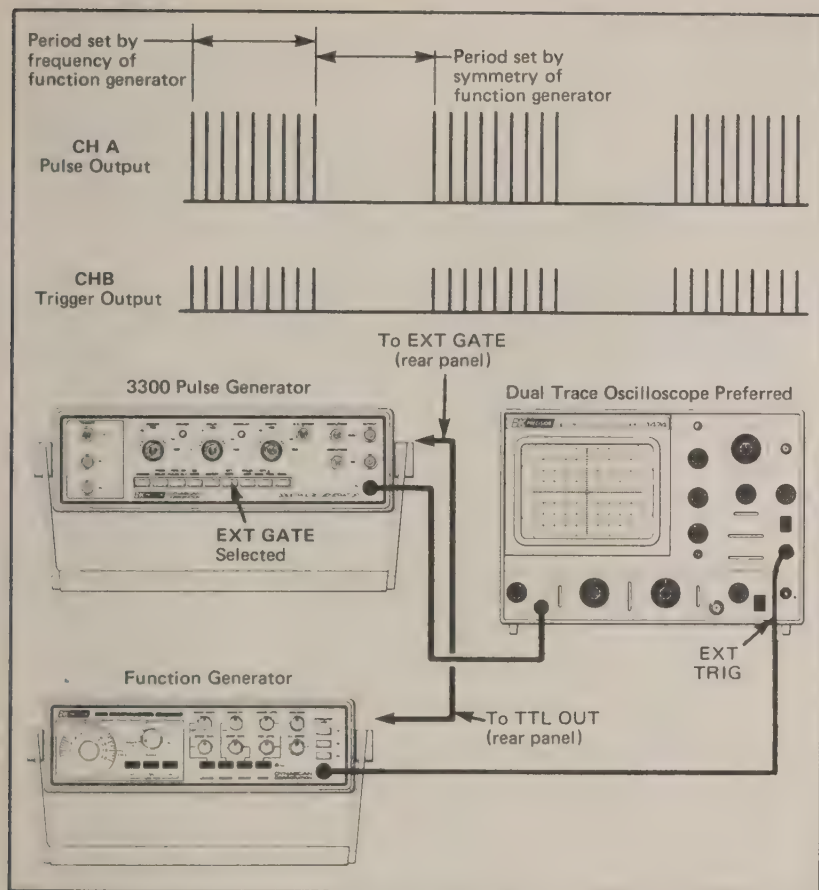


Fig. 9 Generating pulse bursts by external gate operation.

to 100 μ S. Set up the oscilloscope for external triggering from the function generator. A waveform pattern similar to that shown in Fig. 9 should be observed. Increase the width of the pulses and change the frequency of the function generator. Notice that complete pulses are added or subtracted when the frequency of the function generator changes, but that the last pulse is always a whole pulse. This allows circuits to be triggered from the falling edge of the last pulse without changing circuit timing when the burst frequency is varied. Also notice that the OVERLAP indicator works in this mode when the individual pulses overlap within the burst. The OVERLAP LED will also indicate a delay + width overlap if the TRIG OR PULSE DLY button is pushed.

PULSE AMPLIFIER MODE

The pulse amplifier mode permits the Model 3300 Pulse Generator to generate one pulse each time an external trigger signal crosses a preset threshold voltage. The threshold voltage is variable with the TRIGGER LEVEL control. This mode may be used as a level detector, generating a pulse each time a voltage exceeds a preset threshold level, or it can convert almost any waveshape to a pulse signal. Fig. 10 shows how a pulse can be generated at the desired level along a sine wave signal.

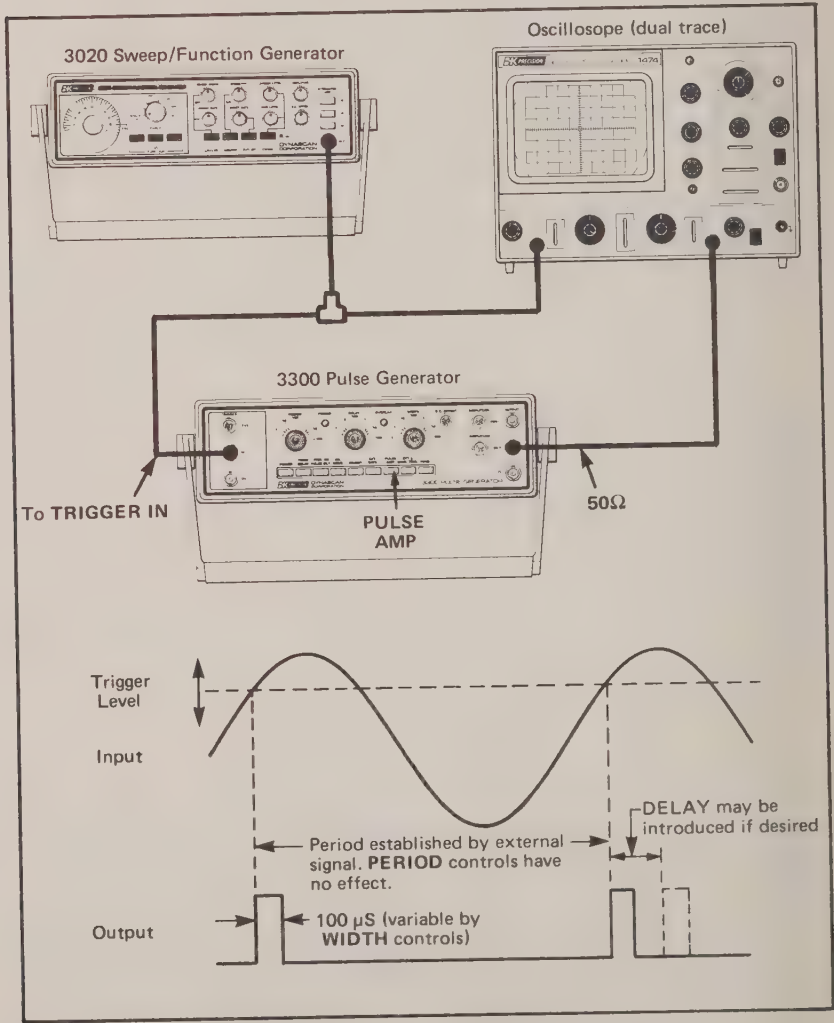


Fig. 10. Pulse amplifier mode of operation.

For demonstration purposes, a function generator may be used to provide the external trigger signal. Use sine wave and triangle wave inputs if desired. Connect the output of the function generator to the TRIGGER IN jack of the Model 3300, and to channel A of an oscilloscope. Connect the pulse output of the pulse generator to channel B or the oscilloscope. Set the scope to trigger from the channel A signal, and set up the function generator to produce a 6-volt peak-to-peak sine wave at 1 kHz. Press the PULSE AMP button on the pulse generator and set the WIDTH controls for 100 μ S. Rotate the TRIG LEVEL control and note that the pulse output will move up and down the slope of the sine wave, disappearing at the top of the sine wave and about 2 volts before the bottom of the waveform. Circuit hysteresis introduces a minimum voltage swing to trigger the pulse generator. The minimum voltage swing required decreases with the frequency of the trigger input.

EXTERNAL TRIGGER MODE

Using the same hook-up as shown in Fig. 10, switch the function generator to square wave and push in the EXT & MAN TRIG button. The 3300 will now generate pulses synchronized with the leading edge of the trigger input. See Fig. 11. This input is designed for triggering from TTL or CMOS levels, and while sine or other waveforms with enough amplitude will trigger the 3300 in this mode, it is not recommended as excessive pulse jitter may occur.

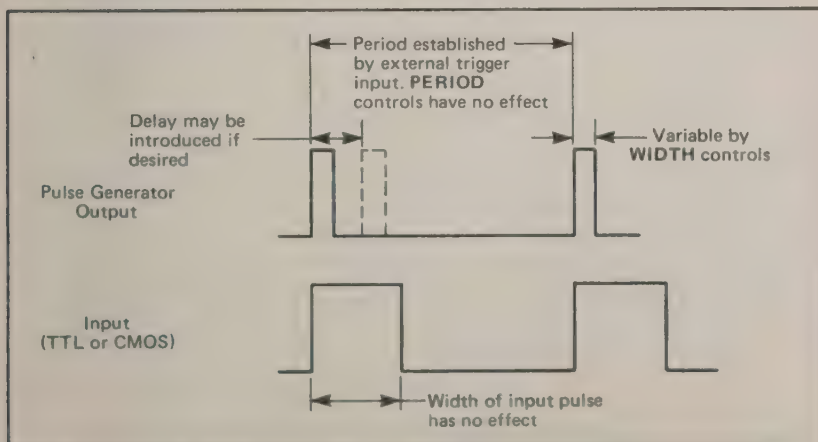


Fig. 11. External trigger operation.

MANUAL TRIGGER MODE

The manual trigger mode will generate one trigger pulse and one output pulse each time the MAN button is pressed. For a demonstration of this mode, connect the TRIGGER OUT jack to channel A of a dual-trace oscilloscope and the TTL OUTPUT jack to channel B. Set up the scope to trigger on the channel A signal. Press the EXT & MAN TRIG button to select this mode, there should be *no* input to the TRIGGER IN jack. Press the MAN button several times and note that there is one trigger pulse on channel A and one output pulse on channel B of the oscilloscope display for each push of the button. In the trigger delay mode, the WIDTH control will vary output pulse width and the DELAY control will vary the trigger pulse width. If the TRIG OR PULSE DLY button is pressed, the output pulse will be delayed by the setting of the DELAY controls. If the delay is set for 1 second, the output pulse will occur 1 second after the MAN button is pressed.

COMBINATIONS OF MODES

Many of the operating modes previously described may be used simultaneously, resulting in a large total number of possible combinations of modes. For example, the pulse output may be inverted in any mode of operation. As another example, in the pulse amplifier mode, undelayed, fixed delay, variable pulse delay, or square wave output may be selected. Table 1 summarizes the combination of modes possible.

Any 1 of these modes:	May be selected in combination with any 1 of these modes:	Any combination of columns 1 and 2 may be in combination with any 1 of these modes:
Fixed Delay	External Gate	Normal pulse output
Pulse Delay	Pulse Amplifier	Inverted pulse output
Square Wave	External Trigger	
*Normal (none of the above)	Manual Trigger	
	Normal (none of the above)	

*Also called "Trigger Delay" mode. In this mode, trigger output width is variable by DELAY control except in modes where external trigger input is selected (Pulse Amp and External Trigger Modes).

Table 1. Possible combinations of modes.

APPLICATIONS

Because this instrument is so versatile, only a few of the most common applications are included in this manual. Additional uses are limited only by the understanding of the instrument and the skill and insight of the technician or engineer using it.

TESTING AND TROUBLESHOOTING DIGITAL LOGIC CIRCUITS

Naturally, the most common application of the 3300 pulse generator is in the design, testing, and servicing of circuits that normally use pulse signals, especially digital logic circuits. The 3300 can generate the same type of signal as normally used in the circuit for signal substitution or signal tracing methods of troubleshooting. An oscilloscope is normally used to examine the output of a circuit while the pulse generator supplies the input. The pulse delay mode is useful if you desire to examine the leading edge of the circuit's output pulse. By using the trigger output of the 3300 as external sync trigger for the oscilloscope, the pulse output can be delayed so that the leading edge of the waveform is visible on the oscilloscope.

For checking AND gates or circuits that require two or more pulses simultaneously, they are readily available from the 3300. In the trigger delay mode, the trigger output and TTL output can be adjusted to be identical, or of different pulse widths. The 50Ω and 600Ω outputs can also be adjusted to be identical to the TTL output if desired. The 50Ω and 600Ω outputs can be inverted with respect to the trigger output if needed. In the pulse delay mode, two sequential pulses are possible using the trigger output and main pulse output.

INTERFACE BETWEEN LOGIC FAMILIES

Fig. 12 illustrates the method for using the 3300 to interface between logic families. Although two examples are shown, a similar set-up could be used to interface any two logic families. When interfacing between logic families the output amplitude of the generator should be set for slightly less than the V_{cc} of the family to prevent over voltaging the inputs. Also, power should be applied to logic circuits before pulses are applied, as it is possible to damage logic inputs without this precaution.

RESPONSE TIME TESTING OF OPTO-ISOLATORS

Fig. 13 shows the test set-up for checking response time of an opto-isolator. The input pulses applied to the opto-isolator from the pulse generator are also applied to the channel A input of a dual-trace oscilloscope. The output pulses of

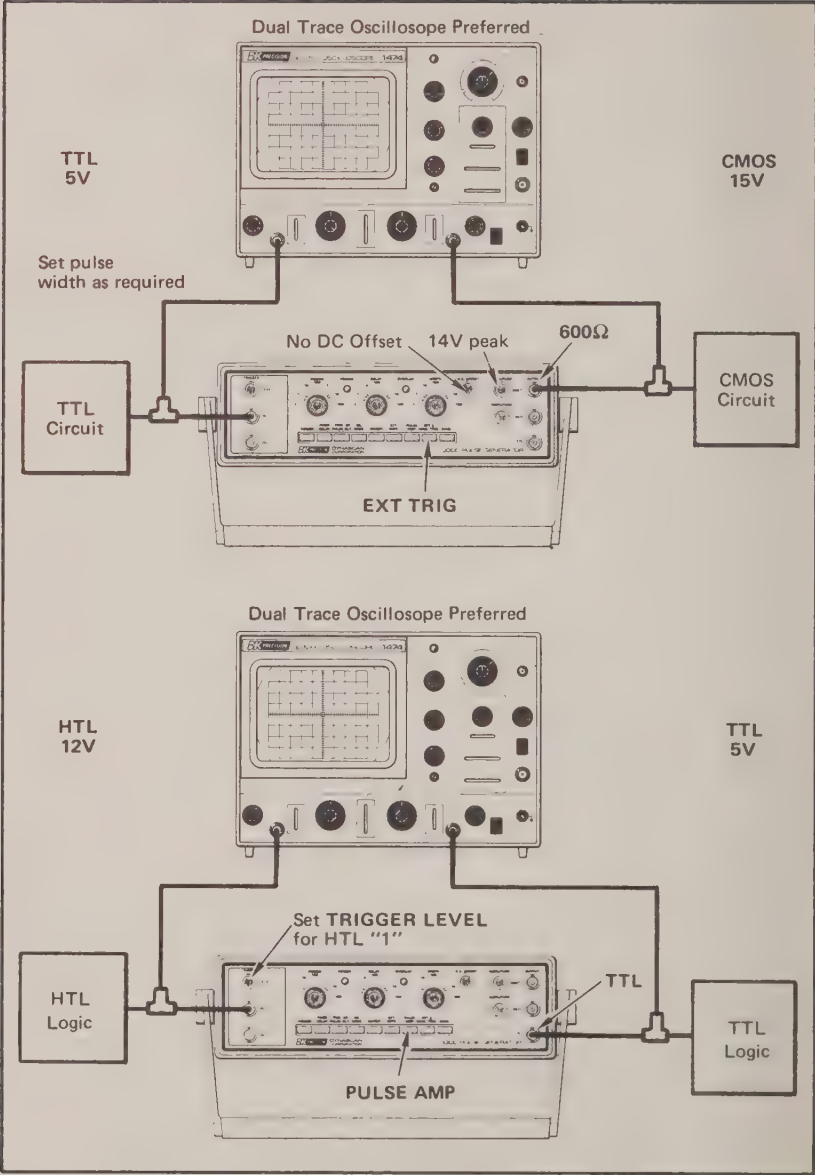


Fig. 12. Interface between logic families.

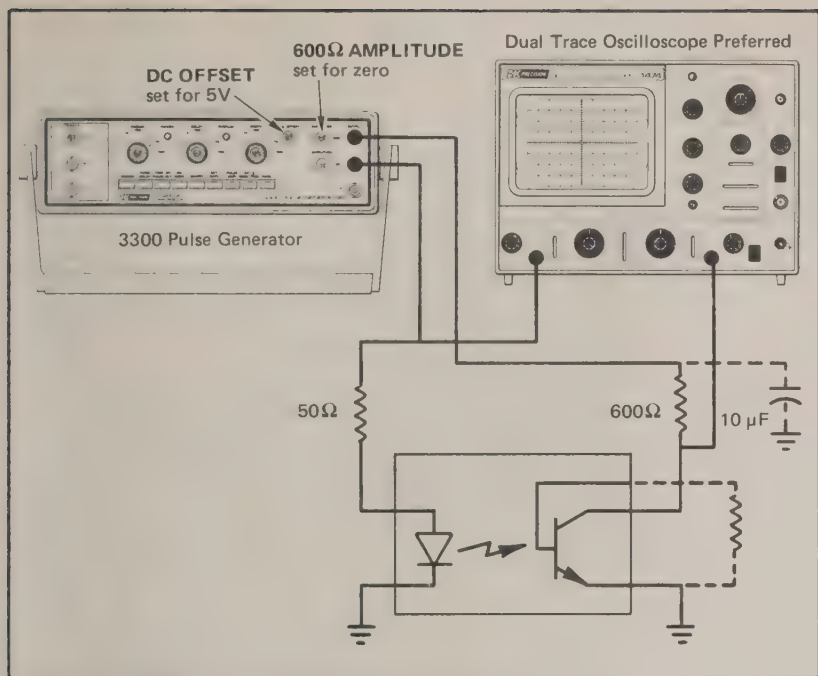


Fig. 13. Testing response time of an opto-isolator.

the opto-isolator are applied to the channel B input of the oscilloscope. Response time is determined by measuring the delay between the channel A and channel B waveform. In this application, the output of the 600Ω section can be used as a DC supply if desired by setting the amplitude to zero and the DC OFFSET control as required. Any residual waveform can be removed with a $10\mu\text{F}$ capacitor if necessary.

TESTING SHIFT REGISTERS

To test shift registers or counters, a quick method of verifying that the outputs are active and that data can be shifted is to use the set-up in Fig. 14. The 3300 is set for pulse bursts by using the EXT GATE mode described previously. A **B & K-PRECISION** Model 3010 Function Generator is shown for providing the external gating signal. The pulse burst can be set for bursts of 1, 2, 3, 4, etc. pulses by varying the 3010 frequency and the 3300 pulse PERIOD. The shift register reset line should go to the 3010 output so the shift register is reset between bursts. The 3300 will clock a high into each succeeding shift register output as the number of pulses in the burst is increased. This way each succeeding shift register output can

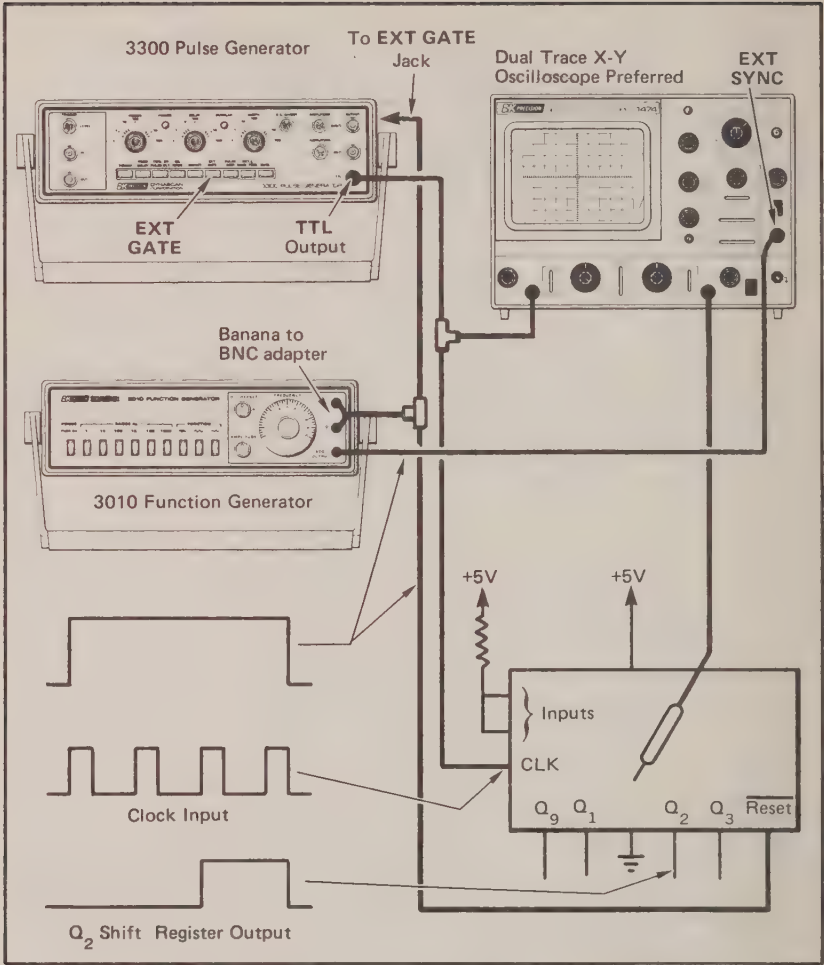


Fig. 14. Testing shift registers.

be made to go high as it is examined on the oscilloscope. The same set-up can be used to check synchronous counters. With ripple counters, the pulse bursts would be fed into the input.

FREQUENCY SHIFT KEYING ACQUISITION TIME TEST

An example of testing an FSK (frequency shift keying) decoder can be seen in Fig. 15. An FSK type signal can be generated using the programmable frequency

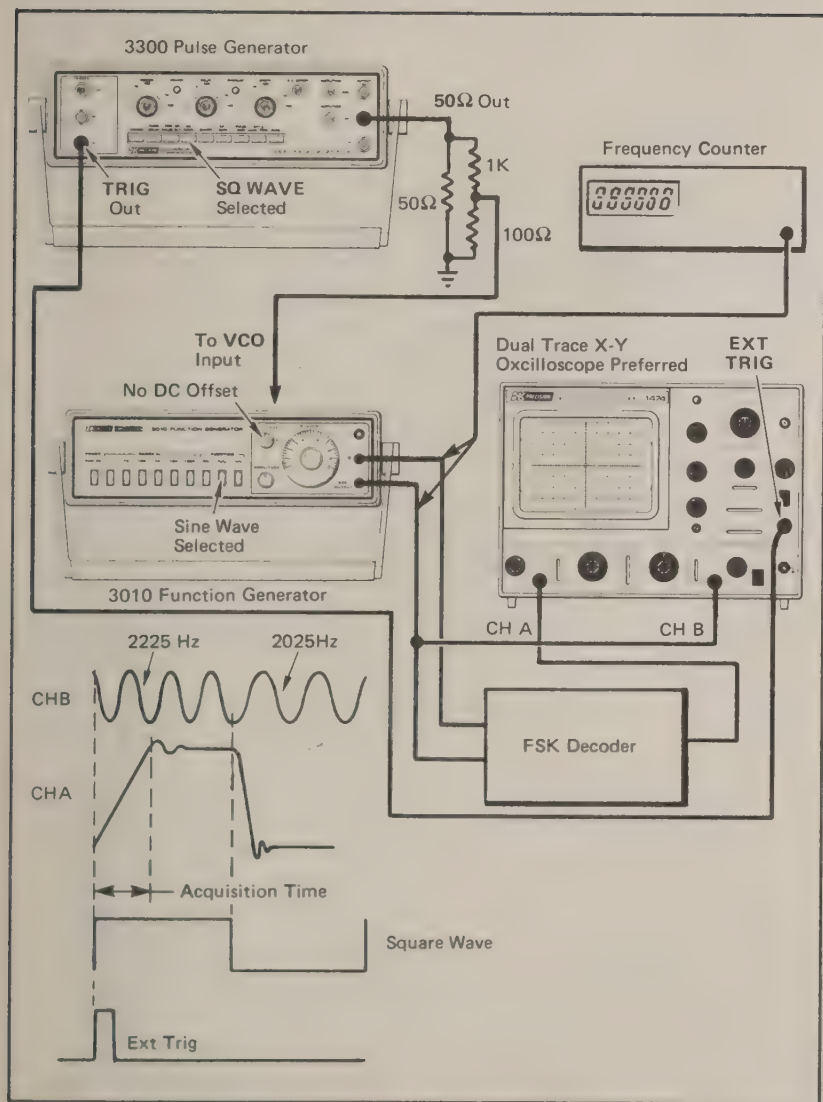


Fig. 15. Frequency shift keying acquisition time test.

capability of the Model 3010 (or 3020) Function Generator. The square wave output of the 3300 Pulse Generator is applied to the VCO input of the function generator. The two states of the square wave signal cause the function generator output to switch between two specific frequencies. If the decoder uses a typical set of frequencies such as 2025 and 2225 Hz, the test can be set up in this manner. The PERIOD control on the 3300 would be set for 10 mS. Turn the WIDTH control and 50Ω AMPLITUDE to minimum (counterclockwise) and adjust the 3010 function generator for a 2025 Hz reading on a frequency counter. Turn the WIDTH control to 10 mS and turn the WIDTH vernier until the OVERLAP just goes on. Turn up the 50Ω AMPLITUDE until the counter reads 2225 Hz. Reset the WIDTH control to 1 mS and push in the SQ WAVE button. The output of the decoder should look like the channel A scope display. The loop time constant can be evaluated.

DEBOUNCE RELAY CONTACTS

To interface a relay to a logic circuit, a means of eliminating contact bounce is needed. Fig. 16 illustrates the use of the 3300 Pulse Generator for such interface. The straight forward method is to push in the EXT & MAN TRIG button, set the pulse WIDTH for 5 mS to 100 mS, depending upon how much bounce the relay contacts have, and connect the relay to the TRIG IN jack of the pulse generator. This will give one pulse to the logic circuit for every relay actuation. There are also situations where a pulse width of 100 mS (or even 5 mS) cannot be tolerated in the logic circuit, but a delay can. In these cases the EXT & MAN TRIG and the TRIG

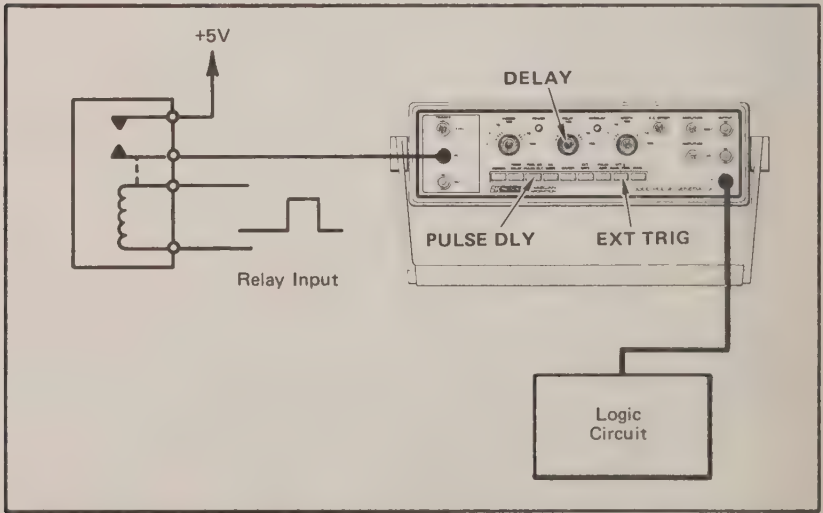


Fig. 16. Eliminating contact bounce in interface between a relay and logic circuitry.

OR PULSE DLY buttons can be depressed. With the pulse DELAY control set for 100 mS and the WIDTH control set for 1 μ S, a narrow 1 μ S pulse for activating the logic circuit can be obtained after waiting 100 mS for the relay contacts to stop bouncing.

SWEEP DELAY GENERATOR

The 3300 can serve as a sweep delay generator for an oscilloscope. One common application is for examining the VITS (vertical interval test signal) portion of a composite video signal. The VITS is very useful for evaluating the IF and video response of a television receiver, but on standard oscilloscopes it is difficult to expand the waveform adequately for thorough evaluation. To view the VITS, vertical sync pulses must be used for oscilloscope sweep triggering. The VITS information does not occur until the 17th and 18th horizontal line after the sync pulse. Without sweep delay, at least 18 lines must be displayed by the sweep to view the VITS. The VITS is then such a small proportion of the total sweep that waveform details are lost.

The 3300 can be used as a variable delay between the vertical sync pulse source and the scope's sweep trigger input. This allows sweep triggering to be delayed to the beginning of the 17th line, or any other desired point. By increasing the sweep speed, the VITS waveform can be expanded to fill the entire screen, or expanded even more to view a portion of the VITS. Fig. 17 and the following paragraph describe how to set-up the 3300 for this application.

If a good source of vertical sync pulse is available, such as the vertical sync output from a digital sync separator, it should be used to trigger the Model 3300. Otherwise, the pulse from the vertical yoke can be used. Connect the vertical sync pulse from the television receiver to the TRIGGER IN jack of the 3300 and press the PULSE AMP button.

WARNING

The TV chassis must be isolated from the power line by an isolation transformer if it doesn't have a power transformer. Do not touch the *horizontal* section of the yoke with the trigger input because of the high pulse voltages present.

Connect the oscilloscope vertical input to the video detector output, and the pulse generator TRIG OUT jack to the oscilloscope external trigger input. Set the oscilloscope trigger on negative slope external trigger. Adjust the DELAY control of the 3300 to allow the trace to start just before the VITS. The trace can be expanded as much as necessary to examine the VITS signal with the sweep speed control of the oscilloscope.

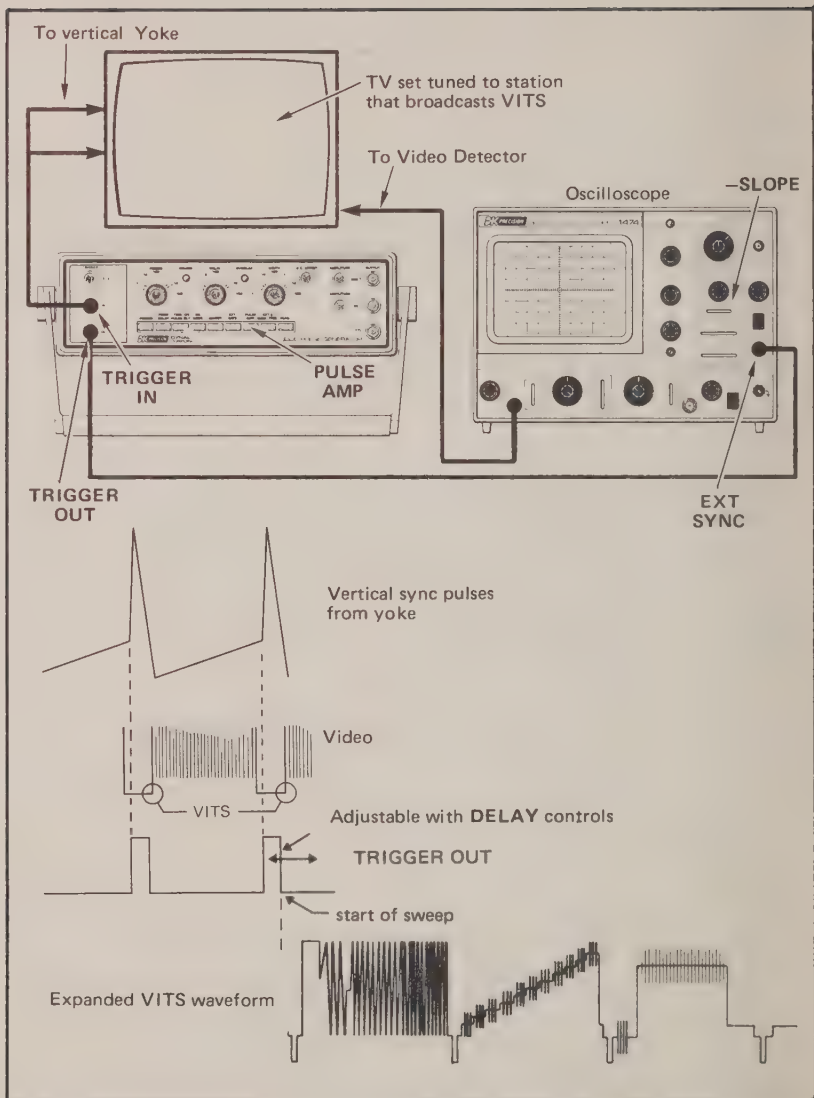


Fig. 17. Sweep delay generator for expanded view of television VITS waveform.

CB NOISE GENERATOR

Troubleshooting and testing of noise blankers and ANL (automatic noise limiter) circuits in citizen's band radio requires a source of simulated ignition noise. The Model 3300 Pulse Generator can generate the standard EIA noise signal for such tests. This is a 1 microsecond pulse at a 100 millisecond repetition period and a 1-volt peak-to-peak amplitude. Fig. 18 shows the equipment interconnections for this test. The noise pulses are applied directly into the antenna coax by using a 50-ohm tee. Use the 50-ohm output of the pulse generator for proper impedance matching. Use an oscilloscope to measure the period; pulse width, and amplitude. Be sure the generator is terminated into the transceiver when amplitude is being measured. The RF generator can be left off until initial pulse measurements are made, then turned on for testing.

In addition to the standard noise signal, with the Model 3300 the pulse width, pulse repetition rate, and amplitude can be varied to check effectiveness of noise blankers and ANL circuits in the presence of other type noise signals.

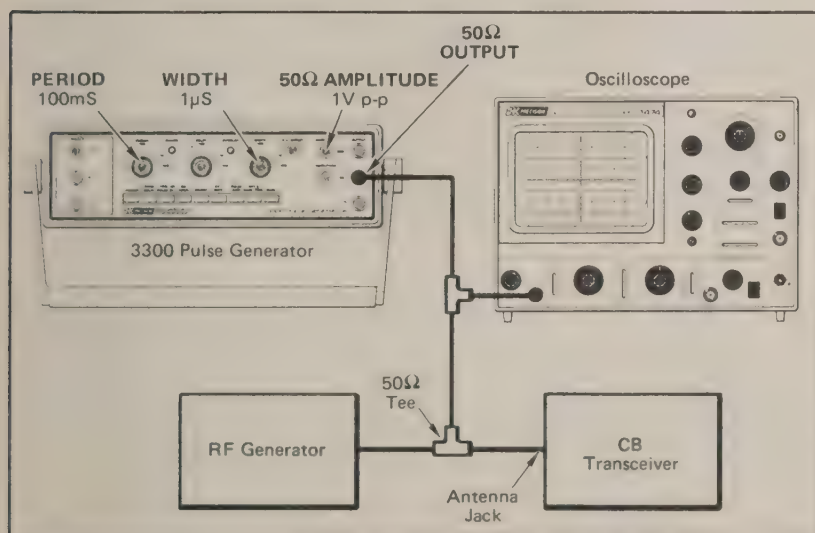


Fig. 18. Noise generator for CB radio testing.

THEORY OF OPERATION

The block diagram, Fig. 22, is located at the rear of this manual on a foldout page that may be used as a reference while reading the explanation that follows. The block diagram defines the circuit breakdown for the generator. Refer to the separately supplied schematic diagram for circuit details.

GENERAL CIRCUIT DESCRIPTION

The main timing circuits of the 3300 Pulse Generator is a variable, gatable oscillator which provides clock pulses to two variable monostable multivibrators (the pulse and delay generators) and a fixed period monostable multivibrator (fixed delay generator).

The trigger input circuit is a high-speed comparator of variable threshold.

Outputs are produced by a linear amplifier for the 600Ω output, a switching circuit for the 50Ω output and a TTL buffer for the TTL output.

A frequency divider gives a square wave output. The overlap indication is provided by a coincidence circuit.

DUAL MONOSTABLE IC2 AND IC3

The dual monostable in the 3300 can be used as an oscillator or single shot generator. The monostable (one shot) timing period is determined by the time it takes the sawtooth which appears on the junction of the timing capacitor and resistor to reach a threshold of approximately 2 volts. At this voltage, the output changes states. The sawtooth appearing at pin 14 of IC2A cycles between approximately 1 volt and 2 volts. The sawtooth at pin 2 of IC2B, IC3A and pin 14 of IC3B may be clamped at a fixed level until reset by a trigger pulse.

PERIOD GENERATOR (CLOCK) IC2A AND IC5D

Monostable (one shot) IC2A uses feedback to make it a free-running oscillator. The output of IC2A (pin 9) is inverted thru IC5 and fed to its input (pin 11). Pin 9 of IC2A is normally low during the timing period determined by the capacitor selected by the PERIOD switch and the resistance selected by PERIOD vernier control. At the end of the timing period, the output goes high. Inverter IC5D inverts this state and feeds it back into the input (pin 11) which switches IC2A's output low and starts another timing period. The narrow pulse generated, about

20 nS, is the trigger pulse for the width and delay monostables. The other input of IC5D, pin 13, is normally held high, which allows IC5D to act as an inverter. In the external gate mode, this input is held low, cutting off the feedback until an external gating signal pulls it high and allows IC2A to send trigger pulses. Gating on IC2A allows burst of pulses to be generated.

DELAY AND WIDTH PULSE GENERATOR MONOSTABLES IC3B AND IC3A

These stages have identical circuits; only the interconnections are different. These monostables generate a single pulse output when triggered by the falling edge of a pulse at the input, pin 5 of IC3A or pin 11 of IC3B. The duration of the pulse from the width monostable is determined by the capacitor selected by the WIDTH switch and the setting of the WIDTH vernier control. Similarly, the delay duration is set by the DELAY switch and DELAY vernier control. From the block diagram, it can be seen that in the standard operating condition (*trigger delay* mode), the width and delay monostables are triggered simultaneously by the output of the period generator. The trigger signal comes through the PULSE AMP and EXT & MAN TRIG switches to the delay monostable and continues on through the TRIG OR PULSE DLY switches to the pulse width monostable. The output of the delay monostable goes through the FIXED DELAY switch to the TRIGGER OUT jack while the output of the width monostable goes through the INVERT and SQ WAVE switches to the output amplifiers and buffers.

If the pulse delay mode is selected by pushing the TRIG OR PULSE DLY button, the width monostable input is connected to the output of the delay monostable. In this mode, the pulse output follows the period generator trigger pulse by the duration of the delay pulse.

FIXED DELAY MONOSTABLE IC2B

Fixed delay monostable IC2B is similar to the width and delay monostable but has a fixed delay of approximately 1 microsecond determined by R21 and C26. When the FIXED DELAY button is pushed, the inputs of the width monostable and the TRIGGER OUT jack are connected to the output of the fixed delay monostable, delaying the pulse output by approximately 1 microsecond.

OVERLAP DETECTOR IC4B

IC4B is a type "D" flip-flop which will transfer and invert the logic level of its input (pin 12) to its output (pin 8) when a clock pulse occurs at pin 11. In the trigger delay mode, overlap occurs if the previous pulse is still present when the next trigger pulse arrives. The input of IC4B is always connected through diode D12 to the output of the width monostable; if this is high when the trigger pulse appears at IC4B's clock input, the high is inverted and transferred to pin 8. This

turns on the OVERLAP LED (D14), indicating an incorrect setting of the WIDTH and/or PERIOD controls. In the pulse delay mode, the other input diode (D13) of the overlap detector is connected to the output of the delay monostable, pin 10 of IC3B. Then, if the duration of either or both of the width or delay pulses exceed the period, the OVERLAP LED will go on.

SQUARE WAVE GENERATOR IC4A

This is a type “D” flip-flop with the inverted output (pin 6) fed back into its data input (pin 2). The clock input (pin 3) comes from the period generator. With every trigger pulse from the period generator, the output of the square wave generator changes states. A complete period of the square wave takes two periods of the period generator; thus the square wave frequency is always 1/2 the frequency of the period generator.

TRIGGER INPUT CIRCUIT Q13, IC1

When the EXT & MAN TRIG or the PULSE AMP switches are pushed, the period generator is disconnected from the width and delay monostables. The output of IC1, the trigger input comparator, is used instead of the output of the period generator. A positive trigger input pulse into the inverting input of IC1 (pin 11) gives a negative pulse out of IC1 (pin 9) which can trigger the delay and width monostables. The feedback path from the output of IC1 to its non-inverting input (pin 12) through R7, C47, and R6 introduces hysteresis so that it will not oscillate with a slowly rising input.

The voltage divider formed by R74, R6, and R7 gives a fixed reference for the external or manual trigger mode. When the trigger input, divided down by the R69, R1, and R65 divider, raises the emitter of Q13 above the fixed reference, the output of IC1 goes low and triggers the delay and width monostables.

Pushing the MAN button applies a voltage through D1 that will trigger IC1 for single pulse outputs.

When the PULSE AMP button is pushed, TRIGGER LEVEL control R3 is connected to the voltage reference point (R74, R6, R7 and pin 12). The voltage can be varied by R3 to provide a variable threshold for triggering from a selected point on an input waveform.

50Ω OUTPUT Q8-Q12

This stage is a variable power supply followed by a transistor switch. High-speed 50Ω output switch Q12 has its base current supplied by FET Q10, connected as a constant current source. The pulse input to the stage is applied at

the base of Q11. When Q11 is off, Q10 applies base current to Q12, turning it on. The output is high. When Q11 turns on, it cuts off Q12 and also pulls down the output through D15. Q8 and Q9 form a variable power supply with the output voltage at the emitter of Q9 set by AMPLITUDE control R54. When Q12 turns on, the emitter voltage of Q9 minus the small drop across Q12 appears at the 50 Ω output (no load).

600 Ω OUTPUT AMPLIFIER Q1-Q5

The output amplifier consists of a differential input stage (Q1-Q2) followed by a common emitter transistor, Q3. The output from Q3 is applied to a push-pull output stage (Q4 and Q5). Negative feedback is applied from the output to the base of Q2 by R33 and R32. The closed loop gain is approximately 10. DC offset is obtained by applying the offset voltage to the base of Q2 also.

POWER SUPPLY IC6-IC8, Q6-Q7, D7-D10

Power transformer T1, bridge rectifier diodes D7, 8, 9, 10 and filter capacitors C27 and C32 generate +26V and -27V unregulated. The +26V is applied to IC6, a 78L18A voltage regulator, which furnishes the regulated +18V output. The +26V is also applied through R40 to IC7, a 78L05A regulator, which furnishes the regulated +5V output. IC8B and Q7 comprise a -18V regulator which is referenced to the +18V supply via R48 and R49. In a similar manner, IC8A and Q6 comprise a -5V regulator which is referenced to the +5 supply via R44 and R45.

MAINTENANCE AND CALIBRATION

WARNING

1. The following instructions are for use by qualified personnel only. To avoid electric shock, do not perform servicing other than contained in the operating instructions unless you are qualified to do so.
2. A shock hazard is present when the case is removed once the line cord is plugged into an AC outlet. Avoid touching the fuse or bottom of the circuit board in the area of the fuse or power transformer. The fuse has 120 VAC (240 VAC on export models) on it even when the POWER switch is off.

REMOVAL OF REAR CASE

To remove the rear case from the generator, proceed as follows:

1. Turn the main (1/4 turn) wrench handle to rotate the case screws. But hold the handle to be sure. Use caution to avoid losing the screws beneath the screw. Then hold the handle on the case. Remove the handle. The handle may be reversed if the user desires. Refer to Fig. 19.
2. Remove the two Phillips-head screws from the rear case.
3. Slide the rear case from the generator.
4. Place the instrument on an insulated surface if power is to be applied with the case removed, such as during servicing and adjustment.
5. To reinstall the rear case on the generator, reverse the above procedure. Be sure the main circuit board slides into the slots inside the case.

240-VOLT TO 120-VOLT CONVERSION, EXPORT MODELS

The 120-volt, 60 Hz power transformer (065-149-9-001), used in the 3300 standard models is replaced by a 120/240-volt 50/60 Hz transformer (065-149-9-002) for the export models. This transformer is prewired at the factory for 240-volt operation but may be rewired for 120-volts if desired. See Fig. 20 for rewiring the transformer for 120-volt operation.

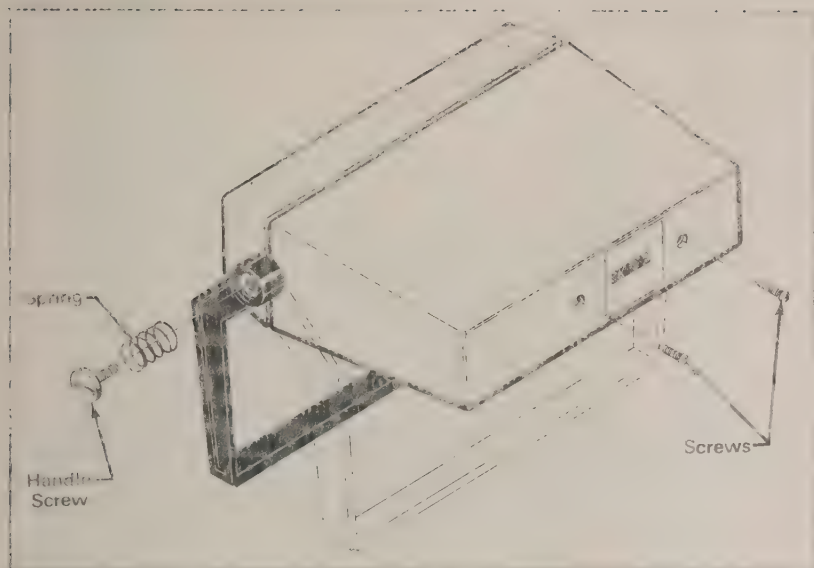


Fig. 19. Removal of rear case.

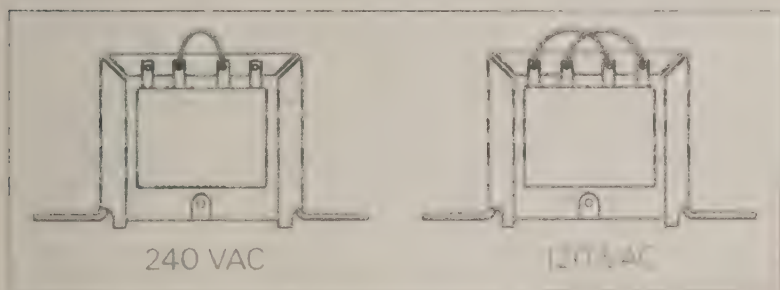


Fig. 20. 120/240-volt transformer wiring.

FUSE REPLACEMENT

The AC line power fuse F1 should not open unless some defect has developed in the instrument. Replace the fuse *only* after investigation of the reason for its opening. Refer to Fig. 21 for fuse location on the main circuit board.

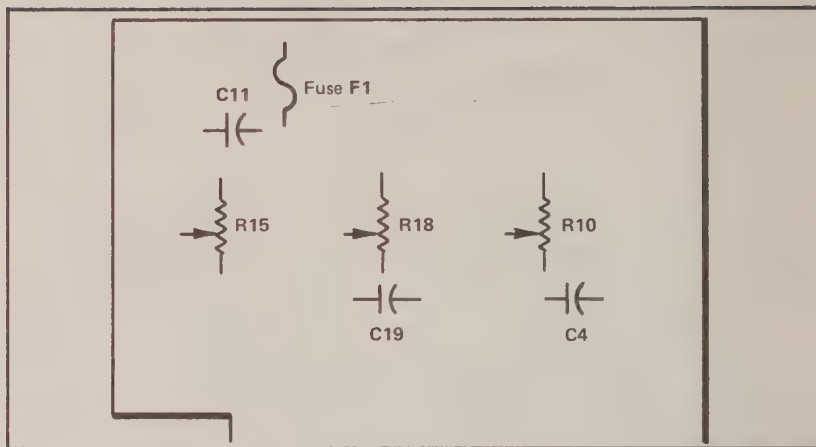


Fig. 21. Location of calibration adjustments and fuse.

CALIBRATION ADJUSTMENTS

This unit was carefully checked and calibrated at the factory prior to shipment. Readjustment is recommended only if repairs have been made in a circuit affecting calibration, or if you have reason to believe the unit may be out of calibration. Complete recalibration procedures are given in this manual. However, calibration adjustments should be attempted only if the proper test equipment is available, and you are experienced and qualified in its use. If the accuracy of the test equipment used for calibration is less than specified, the accuracy of the 3300 will be proportionately degraded. Perform related adjustments in the specified sequence to avoid any undesirable interaction of adjustments.

Test Equipment Required

Frequency Counter. 10 ppm time base or better, (**B & K-PRECISION** Model 1820 or equivalent).

One 0.33 μ F, $\pm 1\%$ capacitor.

PROCEDURE

1. Remove 3300 rear case.
2. Place 3300 on insulated surface.

3. Connect the $0.33\ \mu\text{F}$ 1% capacitor across C11.

4. Set up 3300 controls as follows:

POWER on

PERIOD range switch $1\ \mu\text{S}$. PERIOD vernier control fully counterclockwise.

DELAY range switch $1\ \mu\text{S}$. DELAY vernier control counterclockwise.

WIDTH range switch $1\ \mu\text{S}$. WIDTH vernier control counterclockwise.

All other pushbuttons should be out.

5. Connect frequency counter to TTL OUTPUT of 3300.

6. Adjust R15 until the counter reads 1.15 kHz.

7. Turn off POWER. Reconnect the $0.33\ \mu\text{F}$ capacitor across C4.

8. Turn on POWER.

9. Set the PERIOD range switch for $100\ \mu\text{S}$ and turn the PERIOD vernier control until the frequency counter reads $1.00\ \text{kHz} \pm 0.3\ \text{kHz}$.

10. Turn R10 clockwise until the OVERLAP LED is on and then counterclockwise until it just goes out or is flickering.

11. Turn POWER off. Reconnect the $0.33\ \mu\text{F}$ capacitor across C19.

12. Turn on POWER. Turn the WIDTH range switch to $.1\ \mu\text{S}$ and turn the POWER on. The frequency should still be $1.00 \pm 0.3\ \text{kHz}$. Readjust if necessary.

13. Push in the TRIG OR PULSE DLY button. Turn R18 clockwise until OVERLAP LED goes on and then counterclockwise until it just goes out or flickers.

14. Turn POWER off. Remove the $0.33\ \mu\text{F}$ capacitor and replace rear case.

FIELD EXPEDIENT

A less accurate field calibration can be performed without the frequency counter and 1% capacitor by using an oscilloscope with a calibrated sweep time capability. Almost any oscilloscope with this feature may be used, but calibration accuracy of the 3300 will always be proportionately less than the calibration

accuracy of the oscilloscope used. A **B & K-PRECISION** Model 1479 or equivalent is recommended.

1. Connect the **TTL OUTPUT** of the 3300 to the vertical input of the oscilloscope (channel **A** of dual trace scope).

2. Set up oscilloscope as follows:

Vertical Sensitivity	1 V/div.
Sweep Time	.1 mS/div.
Coupling	DC
Sync Source	Internal, channel A
Slope	+
Triggering Level	Adjust for triggered sweep

3. Set the 3300 controls as follows:

	Range Switch	Vernier Control
PERIOD	1 mS	Counterclockwise
DELAY	100 μ S	Counterclockwise
WIDTH	100 μ S	Counterclockwise

4. Adjust R15 for exactly 10 horizontal divisions between pulses.

5. Change the 3300 controls to the following settings:

	Range Switch	Vernier Control
PERIOD	10 mS	Counterclockwise
DELAY	1 mS	Counterclockwise
WIDTH	1 mS	Counterclockwise

6. Adjust R10 until the pulse width is exactly 10 divisions.

7. Disconnect the **TTL OUTPUT** of the 3300 and connect the **TRIGGER OUT** signal to the vertical input of the oscilloscope.

8. Adjust R18 until the trigger pulse width is exactly 10 horizontal divisions.

WARRANTY SERVICE INSTRUCTIONS

1. Refer to the **MAINTENANCE** section of your B & K-Precision instruction manual for adjustments that may be applicable.
2. If the above-mentioned procedures do not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed). Enclose a letter describing the problem and include your name and address. Deliver to, or ship **PREPAID** (UPS preferred) to the nearest B & K-Precision authorized service agency (see list enclosed with unit).

If your list of authorized B & K-Precision service agencies has been misplaced, contact your local distributor for the name of your nearest service agency, or write to:

Service Department

**B & K-Precision Product Group
DYNASCAN CORPORATION
6460 West Cortland Street
Chicago, Illinois 60635**

LIMITED ONE-YEAR WARRANTY

DYNASCAN CORPORATION warrants to the original purchaser that its B & K-PRECISION product, and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the date of purchase.

DYNASCAN will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized B & K-PRECISION service contractor or the factory service department, accompanied by proof of the date of purchase in the form of a sales receipt.

To obtain warranty coverage, this product must be registered by completing and mailing the enclosed warranty registration card to DYNASCAN, B & K-PRECISION, P.O. Box 35080, Chicago, Illinois 60635 within five (5 days) from the date of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced or removed.

DYNASCAN shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have other rights which vary from state to state.

For your convenience we suggest you contact your B & K-PRECISION distributor, who may be authorized to make repairs or can refer you to the nearest service contractor. If warranty service cannot be obtained locally, please send the unit to B & K-PRECISION Service Department, 6460 West Cortland Street, Chicago, Illinois 60635, properly packaged to avoid damage in shipment.



6460 West Cortland Street
Chicago, Illinois 60635

MP MASTER



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